

WHAT IS CLAIMED IS:

1                    1.        A microstructure for steering light, the microstructure comprising:  
2                    a substrate;  
3                    a structural linkage connected with the substrate and supporting a structural  
4 film, the structural film including a reflective coating; and  
5                    a first hold electrode connected with the substrate at a position laterally  
6 beyond an orthogonal projection of the structural film on the substrate and configured to hold  
7 the structural film electrostatically in a first tilted position with respect to the substrate upon  
8 application of a potential difference between the structural film and the first hold electrode.

1                    2.        The microstructure recited in claim 1 further comprising a first snap-in  
2 electrode connected with the substrate at a position laterally within the orthogonal projection  
3 of the structural film on the substrate and configured to tilt an end of the structural film in a  
4 direction towards the first snap-in electrode upon application of a potential difference  
5 between the structural film and the first snap-in electrode.

1                    3.        The microstructure recited in claim 2 wherein the first snap-in  
2 electrode comprises a polysilicon layer.

1                    4.        The microstructure recited in claim 3 wherein the first hold electrode  
2 comprises a polysilicon bilayer.

1                    5.        The microstructure recited in claim 1 wherein the reflective coating  
2 comprises gold.

1                    6.        The microstructure recited in claim 1 wherein the first hold electrode  
2 comprises a comb structure having a plurality of teeth, the first hold electrode being  
3 configured such that the first tilted position is defined by an angle with respect to the  
4 substrate that depends on the potential difference between the structural film and the first  
5 hold electrode.

1                    7.        The microstructure recited in claim 6 wherein the angle of the first  
2 tilted position deviates increasingly from horizontal with an increase in the potential  
3 difference between the structural film and the first electrode.

1           8.     The microstructure recited in claim 1 further comprising a second hold  
2 electrode connected with the substrate at a position laterally beyond an orthogonal projection  
3 of the structural film and the substrate and on an opposite side of the structural linkage from  
4 the first hold electrode, wherein the second hold electrode is configured to hold the structural  
5 film electrostatically in a second tilted position with respect to the substrate upon application  
6 of a potential difference between the structural film and the second hold electrode.

1           9.     The microstructure recited in claim 8 further comprising first and  
2 second snap-in electrodes connected with the substrate at positions laterally within the  
3 orthogonal projection of the structural film on the substrate and on opposite sides of the  
4 structural linkage, each of the first and second snap-in electrodes being configured to tilt an  
5 end of the structural film in a direction towards that snap-in electrode upon application of a  
6 potential difference between the structural film and that snap-in electrode.

1           10.    The microstructure recited in claim 9 wherein the first and second  
2 snap-in electrodes comprise a polysilicon layer.

1           11.    The microstructure recited in claim 10 wherein the first and second  
2 hold electrodes comprise a polysilicon bilayer.

1           12.    The microstructure recited in claim 8 wherein the reflective coating  
2 comprises gold.

1           13.    The microstructure recited in claim 8,  
2 wherein the first hold electrode comprises a first comb structure having a  
3 plurality of teeth, the first hold electrode being configured such that the first tilted position is  
4 defined by a first angle with respect to the substrate that depends on the potential difference  
5 between the structural film and the first electrode; and  
6 wherein the second hold electrode comprises a second comb structure having a  
7 plurality of teeth, the second hold electrode being configured such that the second tilted  
8 position is defined by a second angle with respect to the substrate that depends on the  
9 potential difference between the structural film and the second electrode.

1           14.    The microstructure recited in claim 13,

2 wherein the first angle deviates increasingly from horizontal with an increase  
3 in the potential difference between the structural film and the first electrode; and  
4 wherein the second angle deviates increasingly from horizontal with an  
5 increase in the potential difference between the structural film and the second electrode.

1 15. A method for fabricating a microstructure for steering light, the  
2 method comprising:  
3 forming a first hold electrode on a substrate;  
4 forming a structural linkage on the substrate;  
5 forming a structural film on the structural linkage; and  
6 depositing a reflective coating on the structural film;  
7 wherein the first hold electrode is at a position laterally beyond an orthogonal  
8 projection of the structural film on the substrate and configured to hold the structural film  
9 electrostatically in a first tilted position with respect to the substrate upon application of a  
10 potential difference between the structural film and the first hold electrode.

1 16. The method recited in claim 15 further comprising forming a first  
2 snap-in electrode on the substrate at a position laterally within the orthogonal projection of  
3 the structural film and the substrate and configured to tilt an end of the structural film in a  
4 direction towards the first snap-in electrode upon application of a potential difference  
5 between the structural film and the first snap-in electrode.

1 17. The method recited in claim 15 wherein the reflective coating  
2 comprises gold.

1 18. The method recited in claim 15 wherein forming a first hold electrode  
2 comprises forming a comb structure having a plurality of teeth, wherein the first hold  
3 electrode is configured such that the first tilted position is defined by an angle with respect to  
4 the substrate that depends on the potential difference between the structural film and the first  
5 hold electrode.

1 19. The method recited in claim 15 further comprising forming a second  
2 hold electrode on the substrate at a position laterally beyond an orthogonal projection of the  
3 structural film on the substrate and on an opposite side of the structural linkage from the first  
4 hold electrode, wherein the second hold electrode is configured to hold the structural film

5 electrostatically in a second tilted position with respect to the substrate upon application of a  
6 potential difference between the structural film and the second hold electrode.

1           20.     The method recited in claim 19 further comprising forming first and  
2 second snap-in electrodes on the substrate at positions laterally within the orthogonal  
3 projection of the structural film on the substrate and on opposite sides of the structural  
4 linkage, each of the first and second snap-in electrodes being configured to tilt an end of the  
5 structural film in a direction towards that snap-in electrode upon application of a potential  
6 difference between the structural film and that snap-in electrode.

1           21.     The method recited in claim 19 wherein the reflective coating  
2 comprises gold.

1           22.     The method recited in claim 19 wherein,  
2 forming a first hold electrode comprises forming a first comb structure having  
3 a plurality of teeth, wherein the first hold electrode is configured such that the first tilted  
4 position is defined by an angle with respect to the substrate that depends on the potential  
5 difference between the structural film and the first hold electrode; and  
6 forming a second hold electrode comprises forming a second comb structure  
7 having a plurality of teeth, wherein the second hold electrode is configured such that the  
8 second tilted position is defined by an angle with respect to the substrate that depends on the  
9 potential difference between the structural film and the second hold electrode.

1           23.     A method for operating an optical switch, the method comprising:  
2 tilting a first end of a micromirror assembly towards a substrate by applying a  
3 first electrostatic force; and  
4 thereafter, holding the micromirror assembly in a first tilted position with  
5 respect to the substrate with a second electrostatic force originating from a point laterally  
6 beyond an orthogonal projection of the micromirror assembly on the substrate.

1           24.     The method recited in claim 23 further comprising:  
2 releasing the micromirror assembly from the first tilted position;  
3 thereafter, tilting a second end of the micromirror assembly towards the  
4 substrate by applying a third electrostatic force; and

5           thereafter, holding the micromirror assembly in a second tilted position with  
6   respect to the substrate with a fourth electrostatic force originating from a point laterally  
7   beyond the orthogonal projection of the micromirror assembly on the substrate.

1           25.    The method recited in claim 24 further comprising:  
2           selecting the first tilted position from a plurality of possible first tilted  
3   positions by establishing a potential difference between the micromirror assembly and a first  
4   electrode used to establish the second electrostatic force; and  
5           selecting the second tilted position from a plurality of possible second tilted  
6   positions by establishing a potential difference between the micromirror assembly and a  
7   second electrode used to establish the fourth electrostatic force.

1           26.    The method recited in claim 23 further comprising selecting the first  
2   tilted position from a plurality of possible first tilted positions by establishing a potential  
3   difference between the micromirror assembly and a first electrode used to establish the  
4   second electrostatic force.

1           27.    A microstructure for steering light, the microstructure comprising:  
2           support means;  
3           tiltable micromirror means connected with the support means; and  
4           first electrostatic-field-generation means for providing an electrostatic field to  
5   hold the tiltable micromirror means in a tilted position with respect to the support means,  
6   wherein the first electrostatic-field-generation means is connected with the support means at a  
7   position laterally beyond an orthogonal projection of the tiltable micromirror means on the  
8   support means.

1           28.    The microstructure recited in claim 27 further comprising second  
2   electrostatic-force-generation means for tilting the tiltable micromirror means, wherein the  
3   second electrostatic-field-generation means is connected with the support means at a position  
4   laterally within the orthogonal projection of the tiltable micromirror means on the support  
5   means.

1           29.    The microstructure recited in claim 27 wherein the first electrostatic-  
2   force-generation means is configured for providing a plurality of electrostatic fields to hold  
3   the tiltable micromirror means in a respective plurality of tilted positions depending on a state  
4   of the first electrostatic-force-generation means.

1           30.     The microstructure recited in claim 27 wherein the tiltable micromirror  
2 means comprises torsion-beam means.

1           31.     The microstructure recited in claim 27 wherein the tiltable micromirror  
2 means comprises cantilever means.

1           32.     A wavelength router for receiving, at an input port, light having a  
2 plurality of spectral bands and directing subsets of the spectral bands to respective ones of a  
3 plurality of output ports, the wavelength router comprising:

4                 a free-space optical train disposed between the input ports and the output ports  
5 providing optical paths for routing the spectral bands, the optical train including a dispersive  
6 element disposed to intercept light traveling from the input port; and

7                 a routing mechanism having at least one dynamically configurable routing  
8 element to direct a given spectral band to different output ports depending on a state of the  
9 dynamically configurable routing element, wherein the dynamically configurable routing  
10 element includes:

11                     a micromirror assembly connected with a substrate by a structural  
12 linkage; and

13                     a first hold electrode connected with the substrate at a position laterally  
14 beyond an orthogonal projection of the micromirror assembly on the substrate and configured  
15 to hold the micromirror assembly electrostatically in a first tilted position with respect to the  
16 substrate upon application of a potential difference between the micromirror assembly and  
17 the first hold electrode.

1           33.     The wavelength router recited in claim 32 wherein the dynamically  
2 configurable routing element further includes a first snap-in electrode connected with the  
3 substrate at a position laterally within the orthogonal projection of the micromirror assembly  
4 and configured to tilt a first end of the micromirror assembly towards the substrate upon  
5 application of a potential difference between the micromirror assembly and the first snap-in  
6 electrode.

1           34.     The wavelength router recited in claim 33 wherein the dynamically  
2 configurable routing element further comprises:

3                 a second hold electrode connected with the substrate at a position laterally  
4 beyond the orthogonal projection of the micromirror assembly on the substrate and on an

5 opposite side of the structural linkage, wherein the second hold electrode is configured to  
6 hold the micromirror assembly electrostatically in a second tilted position with respect to the  
7 substrate upon application of a potential difference between the micromirror assembly and  
8 the second hold electrode; and

9 a second snap-in electrode connected with the substrate at a position laterally  
10 within the orthogonal projection of the micromirror assembly and on an opposite side of the  
11 structural linkage, wherein the second snap-in electrode is configured to tilt a second end of  
12 the micromirror assembly towards the substrate upon application of a potential difference  
13 between the micromirror assembly and the second snap-in electrode.

1 35. The wavelength router recited in claim 32 wherein the first hold  
2 electrode comprises a comb structure having a plurality of teeth, the first hold electrode being  
3 configured such that the first tilted position is defined by an angle with respect to the  
4 substrate that depends on the potential difference between the micromirror assembly and the  
5 first hold electrode.